

### **REMARKS**

Reconsideration and allowance of the above identified application is respectfully requested. Upon entry of this amendment, claim 1 is amended and claims 7-11 are added, leaving claims 1-11 pending with claims 1 and 7 being independent.

Applicants appreciate the indication that claims 2-5 contain allowable subject matter.

#### ***Rejections Under 35 U.S.C. §102(b)***

Claims 1 and 6 are rejected under 35 U.S.C. 102(b) as being anticipated by Funahashi (JP 2004-304512) (hereinafter “Funahashi ‘512”).

Applicants submit that Funahashi ‘512 fails to disclose or render obvious all of the elements of amended independent claim 1.

Independent claim 1 now recites, among other things, a speaker including a support fixed to an internal side of a diaphragm at one end, and fixed to the magnetic circuit via a second edge at another end. Such a structure enables the load imposed, when the diaphragm vertically moves, to be substantially constant, and thus, reduces or eliminates distortions in sound reproductions.

Funasashi ‘512 clearly fails to disclose or render obvious such a structure. Funasashi ‘512 discloses a suspension holder 19 that is fixed to the voice coil 14 on a side of the magnetic circuit at one end, and fixed to the frame 18 via a second edge at another end. There is no disclosure in any of the embodiments in Funasashi ‘512 that the second edge is or could be fixed to any portion other than the frame. *See* Figs. 1, 5-10, 15 and 16. Moreover, Funasashi ‘512 does not disclose any reason to modify the structure recited therein, such that it would render claim 1 obvious.

Therefore, Applicants submit that independent claim 1 and its dependent claims are allowable over the cited prior art.

Claims 1 and 6 are rejected under 35 U.S.C. 102(b) as being anticipated by Funahashi (U.S. patent 7,324,659) (hereinafter “Funahashi ‘659”).

As stated above, claim 1 includes a support fixed to the internal side of the diaphragm at one end, and fixed to the magnetic circuit via a second edge at another end.

Funahashi ‘659 discloses a suspension holder 13 that is fixed to a face of the diaphragm

9 on a side of the magnetic circuit at one end, and fixed to the frame 12 via a second edge (i.e., second surround 11) at the other end. There is no disclosure in Funahashi '659 of a support fixed to an internal side of the diaphragm at one end, and fixed to the magnetic circuit via a second edge at another end. *See* Figs 1, 6, 8, 11 and 16. Moreover, Funahashi '659 does not disclose any reason to modify the structure recited therein, such that it would render claim 1 obvious.

Therefore, Applicants submit that independent claim 1 and its dependent claims are allowable over Funahashi '659.

#### ***New Claims 7-11***

New independent claim 7 is allowable since it contains subject matter indicated allowable by the Examiner. Specifically, independent claim 7 is generally dependent claim 3 rewritten in independent form including the base claim.

Claims 8-10 are allowable since they are dependent from independent claim 7.

Claim 11 is allowable since it is dependent from independent claim 1.

### ***Conclusion***

In view of the above amendments and remarks, it is submitted that the present application is now in condition for allowance. However, if the Examiner should have any comments or suggestions to help speed the prosecution of this application, the Examiner is requested to contact the Applicant's undersigned representative.

Respectfully submitted,

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## DESCRIPTION

### SPEAKER

This application is a U.S. national phase application of PCT  
5 International Application PCT/JP2006/303024.

### TECHNICAL FIELD

The present invention relates to a speaker for use in various  
10 ~~kind~~types of electronic equipment.

### BACKGROUND ART

Conventional speakers generally have the following ~~general~~  
structures. One of the conventional speakers includes a frame, a  
magnetic circuit, a voice coil, a diaphragm, and a damper. The frame  
15 has a cylindrical shape with a bottom face and an open top. The  
magnetic circuit is placed on the inner bottom face of the frame. A coil  
portion of the voice coil is disposed in a magnetic gap of this magnetic  
circuit. The diaphragm is disposed in the opening of the ~~frame~~frame,  
so that the inner periphery thereof is fixed to the voice coil and the  
20 outer periphery thereof is fixed to the frame via an edge. The damper  
is fixed to the voice coil at one end thereof, and to the frame at the other  
end thereof. ~~The~~A speaker with this conventional structure is  
disclosed in Fig. 8 of Japanese Patent Unexamined Publication No.  
H11-150791, ~~for example~~.

25 However, the conventional speaker has ~~the an~~edge along the  
outer periphery of the diaphragm, and the damper is fixed to the voice  
coil, which is fixed to the diaphragm. In these ~~edge and damper~~types  
of speakers, the load imposed from the edge and damper in the upward

and downward directions when the diaphragm moves vertically is not substantially constant. As a result, distortions can occur in the reproduction of sounds. Additionally, because both the edge and damper are fixed to the frame, downsizing of the speaker is generally  
5 ~~difficult in some cases.~~

## SUMMARY OF THE INVENTION

The present invention provides a speaker that prevents occurrence of distortions when the diaphragm vertically moves in sound  
10 reproduction ~~and~~. Additionally, the present invention provides a speaker that can be downsized.

A speaker of the present invention includes a frame, a magnetic circuit, a voice coil, a diaphragm, and a support. The frame has a cylindrical shape with a bottom face and an open top. The magnetic  
15 circuit is placed on the inner bottom face of the frame. A coil portion of the voice coil is disposed in a magnetic gap of this magnetic circuit. The diaphragm is disposed in an opening of the frame so that the inner periphery thereof is fixed to the voice coil and the outer periphery thereof is fixed to the frame via a first edge. The support is fixed to  
20 the diaphragm on the magnetic circuit side at one end of the support, and to the vicinity of the magnetic circuit via a second edge at the other end. The first edge is substantially analogous to the second edge in shape with respect to the boundary between the first and second edges.

With this structure that has no damper and has the diaphragm  
25 supported near the magnetic circuit via a support, the first edge along the outer periphery of the diaphragm is substantially analogous in shape to the second edge at the other end of the support, with respect to the boundary between the first and second edges. For this reason, the

load imposed when the diaphragm vertically moves is substantially constant, and thus distortions in sound reproduction are unlikely to occur. Further, the second edge at the other end of the support is fixed to the vicinity of the magnetic circuit. This structure allows  
 5 downsizing more easily than fixing the second edge to the frame.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view illustrating a structure of a speaker in accordance with a first exemplary embodiment of the present invention.

10 Fig. 2 shows characteristics of harmonic distortion factors of the speaker in accordance with the exemplary embodiment.

Fig. 3 is a sectional view illustrating a structure of a speaker in accordance with a second exemplary embodiment of the present invention.

15 Fig. 4 is a sectional view illustrating a structure of a speaker in accordance with a third exemplary embodiment of the present invention.

## REFERENCE MARKS IN THE DRAWINGS

- |    |   |                  |
|----|---|------------------|
| 20 | 1 | Frame            |
|    | 2 | Magnetic circuit |
|    | 3 | Magnetic gap     |
|    | 4 | Coil portion     |
|    | 5 | Voice coil       |
| 25 | 6 | First edge       |
|    | 7 | Diaphragm        |
|    | 8 | Support          |
|    | 9 | Second edge      |

- 10 Yoke
- 11 Magnet
- 12 Plate
- 13, 14 Fixed part

5

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Hereinafter, a description is provided of exemplary embodiments of the present invention with reference to the accompanying drawings.

### 10 FIRST EXEMPLARY EMBODIMENT

Fig. 1 is a sectional view illustrating a structure of a speaker in accordance with the first exemplary embodiment of the present invention. Fig. 2 shows characteristics of harmonic distortion factors of the speaker of the exemplary embodiment. In Fig. 1, the speaker includes frame 1, magnetic circuit 2, voice coil 5, diaphragm 7, and support 8. Frame 1 has a cylindrical shape with a bottom face and an open top (shaped like a bowl). Magnetic circuit 2 is disposed on the inner bottom face of frame 1.

Voice coil 5 has a cylindrical shape so that coil portion 4 thereof is disposed in magnetic gap 3 of magnetic circuit 2. Diaphragm 7 is disposed in the opening of frame 1. The diaphragm has an internal and an external side and a donut shape so that the inner periphery thereof is fixed to voice coil 5, and the outer periphery thereof is fixed to frame 1 via first edge 6. Support 8 is fixed to diaphragm 7 on the side of magnetic circuit 2 (i.e., the internal side of the diaphragm) at one end of the support, and to the upper end of yoke 10 of magnetic circuit 2 via second edge 9 at the other end. Magnetic circuit 2 is made of yoke 10, magnetic circuit 11, and plate 12.

Both of first edge 6 and second edge 9 are formed of a rubber material. With reference to Fig. 1, first edge 6 has an upwardly-projecting circular section, and second edge 9 has a downwardly-projecting circular section. First edge 6 is substantially  
 5 analogous to second edge 9 in shape with respect to the boundary therebetween (i.e., first edge 6 and second edge 9 have substantially the same shape). First edge 6 can be formed to have a downwardly-projecting circular section, and second edge 9 can be formed to have an upwardly-projecting circular section, in Fig. 1.

10 When sound electric signals are passed through coil portion 4 of voice coil 5 in the above structure, the influence of the magnetic flux in magnetic gap 3 allows voice coil 5 to vertically move diaphragm 7. Thus, sounds are reproduced. At this time, as described above, both of first edge 6 and second edge 9 are made of the same material, e. g.  
 15 rubber materials. First edge 6 has an upwardly-projecting circular section, and second edge 9 has a downwardly-projecting circular section.

With this structure, first edge 6 is substantially analogous to second edge 9 in shape with respect to the boundary therebetween, and  
 20 first edge 6 and second edge 9 are made of the same material. For this reason, the load imposed when diaphragm 7 vertically moves is the same even in the upward motion and downward motion of diaphragm 7. As a result, distortions are unlikely to be caused by asymmetrical upward and downward motions in sound reproduction.

25 As shown by "conventional speaker" in Fig. 2, the load imposed by the edge and damper of the conventional speaker when the diaphragm vertically moves is not substantially constant in the upward and downward directions. As a result, particularly at low frequencies,



large distortions occur. In contrast, for a speaker of this exemplary embodiment, as similarly shown by “speaker of the present invention”, the load imposed when diaphragm 7 vertically moves is the same in the upward and downward motions of diaphragm 7. Thus, it ~~is~~can be  
 5 understood that even at low frequencies, occurrence of harmonic distortions are considerably reduced in comparison with the conventional speaker.

If second edge 9 at the other end of support 8 is fixed to frame 1 on the outer peripheral side of magnetic circuit 2 like the conventional  
 10 structure, the frame must be enlarged so that the second edge is movable. However, because second edge 9 at the other end of support 8 is fixed to the end of yoke 10 in this exemplary embodiment, a movable range of second edge 9 is sufficiently ensured on the outer peripheral side of yoke 10 even without frame 1 enlarged. As a result,  
 15 the speaker can easily be downsized.

## SECOND EXEMPLARY EMBODIMENT

Fig. 3 is a sectional view illustrating a structure of a speaker in accordance with the second exemplary embodiment of the present  
 20 invention. In Fig. 3, the same elements used in Fig. 1 are denoted with the same reference marks and descriptions thereof are omitted. The speaker of this exemplary embodiment includes cylindrical fixed part 13 along the outer periphery of yoke 10. Second edge 9 is fixed to the upper end of fixed part 13. This structure ~~can~~may prevent the  
 25 inflow of an adhesive into magnetic gap 3 when second edge 9 is bonded with the adhesive, and ensure the distance from the second edge to magnetic gap 3 and a bonding space at the same time.

As described above, similar to the first exemplary embodiment,

first edge 6 is substantially analogous to second edge 9 in shape with respect to the boundary therebetween. Thus, the load imposed when diaphragm 7 vertically moves is the same in the upward and downward motions of diaphragm 7. As a result, distortions are unlikely to occur  
 5 in sound reproduction. As for the harmonic distortion factors of this embodiment, substantially similar characteristics to those of the first exemplary embodiment shown in Fig. 2 can be obtained. Further, because second edge 9 at the other end of support 8 is fixed to fixed part 13 provided along the outer periphery of yoke 10, a movable range of  
 10 second edge 9 is sufficiently ensured on the outer peripheral side of fixed part 13 even without the frame enlarged. As a result, the speaker can easily be downsized.

~~In similar~~Similarly to a third exemplary embodiment, which will be described later, when the distance from the bottom face of frame 1 to the side end face of second edge 9 of fixed part 13 is smaller than the  
 15 distance from the bottom face to the end of yoke 10 constituting magnetic circuit 2, the inflow of the adhesive into magnetic gap 3 can be more ~~securely~~easily prevented.

## 20 THIRD EXEMPLARY EMBODIMENT

Fig. 4 is a sectional view illustrating a structure of a speaker in accordance with the third exemplary embodiment of the present invention. In Fig. 4, the same elements used in Fig. 1 are denoted with the same reference marks and descriptions thereof are omitted.  
 25 The speaker of this exemplary embodiment includes cylindrical fixed part 14 integral with frame 1 along the outer periphery of yoke 10, and second edge 9 is fixed to the upper end of fixed part 14. The distance from the bottom face of frame 1 to the side end face of second edge 9 of

fixed part 14 is smaller than the distance from the bottom face to the end of yoke 10 constituting magnetic circuit 2. In other words, the height of fixed part 14 is smaller than the end of yoke 10 in the direction toward the bottom face of frame 1.

5           With this structure, the height of fixed part 14 to which second edge 9 is bonded is smaller than the height of yoke 10. This structure  
~~enables more securely prevent~~prevention or reduction of the inflow of  
 an adhesive into magnetic gap 3 when second edge 9 is bonded with the  
 adhesive, and ~~ensures~~ensures the distance from the second edge to  
 10   magnetic gap 3 ~~is maintained, along with~~and an adhesive space.  
 Further, this embodiment has an advantage of reducing the number of  
 components and costs, in comparison with the second exemplary  
 embodiment. The height of fixed part 13 of the second exemplary  
 embodiment can be reduced ~~in a similar~~similarly to the fixed part of the  
 15   third exemplary embodiment.

As described above, ~~similar~~similarly to the first and second  
 exemplary embodiments, first edge 6 is substantially analogous to  
 second edge 9 in shape with respect to the boundary therebetween.  
 Thus, the load imposed when diaphragm 7 vertically moves is the same  
 20   in the upward and downward motions of diaphragm 7. As a result,  
 distortions are unlikely to occur in sound reproduction. As for the  
 harmonic distortion factors of this embodiment, substantially similar  
 characteristics to those of the first exemplary embodiment shown in Fig.  
 2 can be obtained. Further, because second edge 9 at the other end of  
 support 8 is fixed to fixed part ~~13~~14 provided along the outer periphery  
 25   of yoke 10, a movable range of second edge 9 is sufficiently ensured on  
 the outer peripheral side of fixed part ~~13~~14 even without the frame  
 enlarged. As a result, the speaker can easily be downsized.

## INDUSTRIAL APPLICABILITY

As described above, a speaker of the present invention is unlikely to cause distortions when a diaphragm thereof vertically moves in sound reproduction and can be downsized. Thus, the invention is  
5 useful as a speaker, for example, for use in various kinds of electronic equipment.

**ABSTRACT**

Disclosed is a speaker ~~unlikely to cause~~configured to reduce or  
eliminate distortions when a diaphragm thereof vertically moves in  
sound reproduction and which can be downsized. This speaker  
5 includes: a cylindrical frame having a bottom face and an open top; a  
magnetic circuit disposed on a inner bottom face of the frame; a voice  
coil having a coil portion thereof disposed in a magnetic gap of the  
magnetic circuit; the diaphragm disposed in an opening of the frame,  
and fixed to the voice coil along an inner periphery thereof, and to the  
10 frame via a first edge along an outer periphery thereof; and a support  
fixed to the diaphragm on the side of the magnetic circuit at one end  
and to the vicinity of the magnetic circuit via the second edge on the  
other end. The first edge is substantially analogous to the second edge  
in shape with respect to the boundary therebetween.